Space Weather Technical Forecast

Issued on Friday 1 November 2024 at 12:16 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Moderate to High solar activity with M-flares expected, and a chance of further X-class flares. S1 Minor Storm slowly easing.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: High following a peak flare of X2.0 at 31/2120 UTC from AR3878 in the northeast. There are thirteen active regions, consisting of eleven numbered and two unnumbered regions. AR3878 is statistically the most likely flare source, with two delta spots visible within its larger trailer, this is being born out with this region having now produced two X-class flares. AR3869 is now the most complex and active region within the cluster of spots in the southwest, it remains the opposite polarity to what would be expected for a southern disc sunspot ("anti-Hale"), although the magnetic demarcation between this spot and sounding regions is somewhat unclear. There remains other notable regions as well, with the two sunspots in the northwest, AR3874 and particularly AR3875, both presenting a risk of flares.

No clearly Earth-directed CMEs were observed in available imagery. No notable CME has been observed from the X2.0 flare.

Solar Wind / Geomagnetic Activity: Solar winds saw a generally decreasing trend from elevated levels around 520km/s to current slightly elevated levels of around 420km/s, briefly interrupted by the arrival of a weak transient feature at 31/1930 UTC with a further arrival around 021/0630UTC. Density was mostly below average, showing a very slight increase following the transients. The Interplanetary Magnetic Field (IMF), Bt, was predominantly weak around 5-8nT, but saw an increase to moderate levels, 8-10nT, following both transient arrivals. The north-south component, Bz, initially varying weekly between -6nT and +7nT became more persistently and moderately negative following the first transient arrival, reaching a minimum of -8nT. Following the second transient arrival mainly positive values have been observed up to +9nT . Phi angle was predominately negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp1-3), but with an Active (Kp4) interval between 31/2100-2359UTC.

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was at S1 Minor Radiation Storm throughout, slowly easing from around 24pfu to near 10pfu by 01/1200 UTC. High energy electron flux (greater than 2MeV) observed by GOES16 was Background to Moderate. The associated 24-hour fluence was well below the Active threshold, with 7.31e6 integrated flux observed at 01/0000UTC.

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Four-Day Space Weather Forecast Summary

Solar Activity: Moderate or High activity is expected to continue into the start of the period, with occasional M-class flares expected and a chance of further isolated X-class flares. By day 3 (3 Nov) onward flare risk perhaps reducing somewhat as the cluster of active regions in the southwest begin to rotate off the visible disk.

Solar Wind / Geomagnetic Activity: There are no further CME arrivals currently expected, however given the number of active regions and filaments on the disc, this may change at short notice. Mainly Quiet to Unsettled (Kp2-3) geomagnetic intervals expected, with a chance of Active (Kp4) and a slight chance of G1 Minor Storm (Kp5) intervals should Earth experience any further transient arrivals. There is a slight chance of Active to G1 Minor Storms from later on day 2 (02 Nov), should connection to CH86/+, or more likely CH87/+ occur, but with a greater likelihood of connection by day 3 (03 Nov).

Energetic Particles / Solar Radiation: The high energy proton flux at GOES-18 is currently at S1 Moderate Radiation Storm, but slowly declining, and thought likely to fall below this level through day 1 (01 Nov). However, any further notable flares will bring the potential for further enhancement. The high energy electron flux is expected to be Background to Moderate, with the associated fluence forecast to persist below Active levels.

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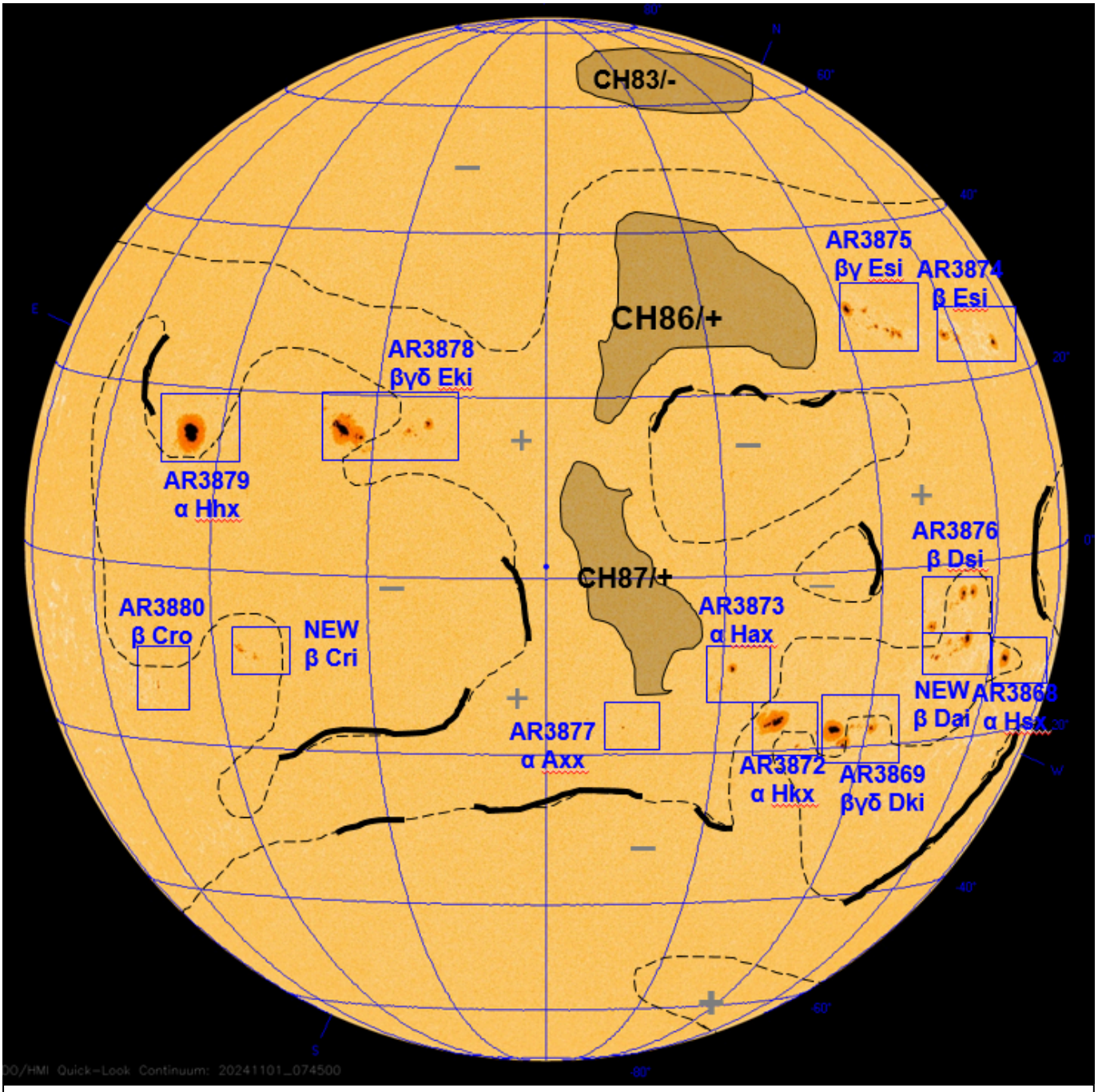
Figure 1: Solar Synoptic Map Vt01/0800UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are currently no Earth-directed CMEs expected. However, as demonstrated by the two unexpected transient arrivals at L1, given recent imagery issues there is lower than usual forecast confidence. This combined with the number of filaments on the Earth-facing disc, along with the continued chance for notable flares, results in a CME forecast which has a greater than usual potential to change at short notice in the coming days.

Recent faster winds, most likely associated with CH85/-, were expected to slowly ease through days 1-2 (01-02 Nov), but may now persist at slightly elevated levels having given way to transient CME influence from an uncertain source. Into the period influence from CH86/+, or more likely CH87/+ to its south, may cause further enhancement back to elevated levels through the later part of day 2 (02 Nov) or more likely into day 3 (04 Nov) . While this feature is a recurrent one, it appears larger and more prominent on this rotation, which suggests that the current solar wind increase might be underestimated by the MOSWOC ENLIL model.

Mainly Quiet to Unsettled geomagnetic activity is expected, with a chance of Active and a slight chance of G1 intervals given any further transient impacts. There is a slight chance of Active to G1 Minor Storms from later on day 2 (02 Nov), should connection to CH86/+, or more likely CH87/+ occur, but with a greater likelihood of connection by day 3 (03 Nov).

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	10	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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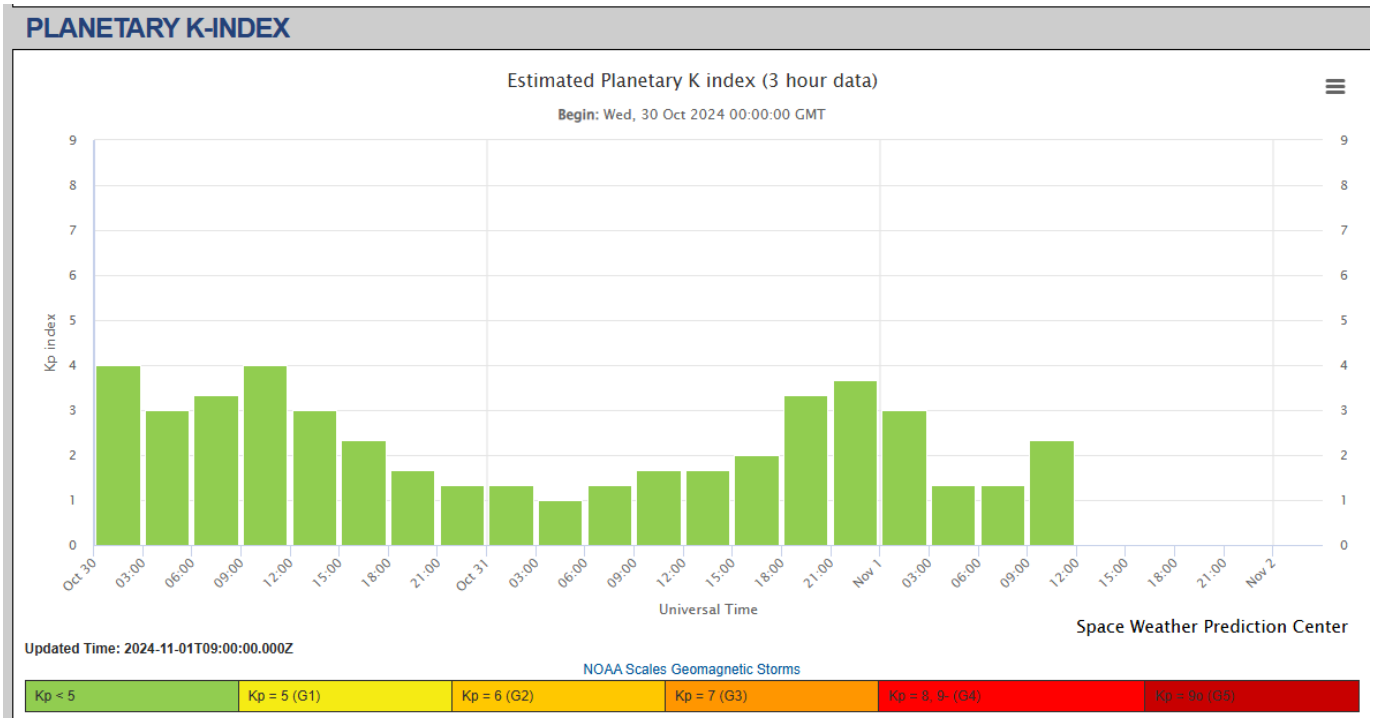
Figure 2: Estimated Planetary K-Index from NOAA SWPC



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Radio Blackouts - X-Ray Flares

There are thirteen active regions, consisting of eleven numbered and two unnumbered regions. AR3878 is statistically the most likely flare source, with two delta spots visible within its larger trailer, this is being born out with this region having now produced two X-class flares. AR3869 is now the most complex and active region within the cluster of spots in the southwest, it remains the opposite polarity to what would be expected for a southern disc sunspot ("anti-Hale"), although the magnetic demarcation between this spot and sounding regions is somewhat unclear. There remains other notable regions as well, with the two sunspots in the northwest, AR3874 and particularly AR3875, both presenting a risk of flares.

Moderate or High activity is expected to continue, with occasional M-class flares expected and a chance of further isolated X-class flares. By day 3 (3 Nov) regions leaving the western limb may see a slight decrease in flare risk, with recurrence and far-side sounding imagery not suggesting any significant oncoming regions. Therefore the flare risk reducing somewhat into the period, although Moderate activity remains likely pending further developments.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	80	80	70	70
Very Active	R3-R5 (X Class)	Yes	30	30	20	20

Figure 3: X-Ray flares from GOES18

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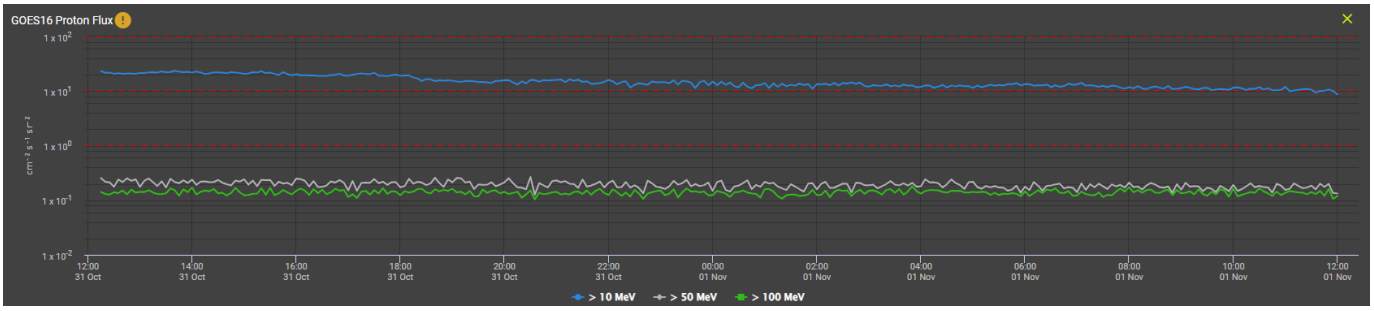
Solar Radiation Storms (High Energy Protons)

Recent transient and X-flare activity elevated the high energy proton flux at GOES-18 over previous days, which after peaking at S2 Moderate Radiation Storm on 29 Oct, is now slowly easing. This is now at S1 Minor Radiation storm level and despite some recent further transient enhancements is expected to likely fall below this level through day 1 (01 Nov).

Further enhancements remain possible however, with the potential for notable flares from a number of the sunspots on the disc. This includes the cluster of regions in the south-centre disc, plus AR3876 to the northwest of this cluster, all of which will remain in geo-effective positions through the period. Notable flares are also possible from AR3878 in the northeast, and while less likely produce observable protons at Earth, this cannot be ruled out.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	90	30	20	20
Very Active	**≥ S3 ***	No	5	5	5	5
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES16 Proton Flux



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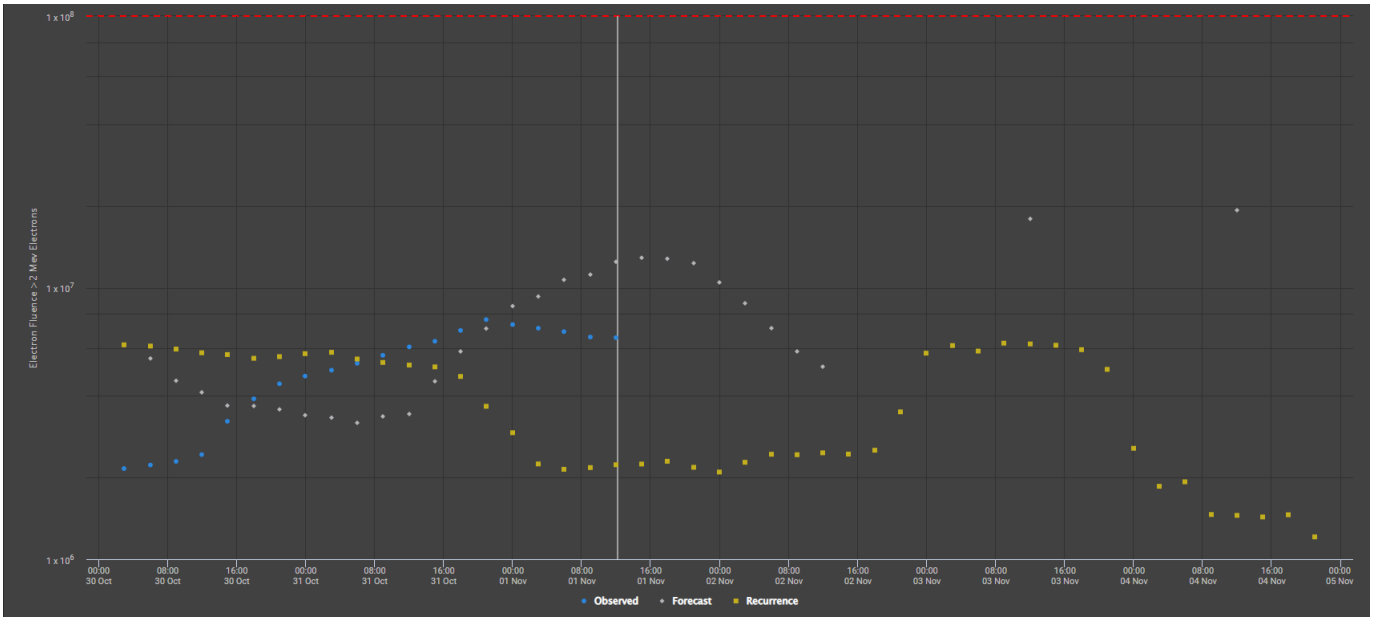
High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) as observed by GOES16 is currently at background and expected to persist mostly at this level, with only brief spells of moderate enhancement expected.

The associated 24-hour fluence is currently expected to remain well below Active throughout the period, with the MOSWOC REFM forecast though to be providing reasonable guidance to staying below this Active level, although is believed to be over-estimating the forecast fluence towards the end of the period.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	5
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 5: Latest MOSWOC REF Model



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